Anekant Education Society's
Tuljaram Chaturchand College of Arts, Science and Commerce, Baramati

Autonomous

Course Structure for M.Sc.II Mathematics

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Class : M.Sc II (Semester- III)

Paper Code : MAT5301

Paper : I Title of Paper: Combinatorics

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- It is a part of applied mathematics which is applicable to Statistics, Engineering.
- To solve rearrangement problems, selection problem, rook problems.

B) Learning Outcome:

Students are able to understand the how to convert real life situations into a mathematical problem like arrangement problem, selection problems, distribution problems, Recurrence relation, Generating function and applications in Engineering , Physics , Number theory .

Topics/Contents:

Unit 1- General Counting Methods: Counting Principles, Arrangements and selections, Arrangements and selections with Repetitions, Distributions, Binomial Identities,

Unit 2-Generating Functions: Generating Function Models, Calculating coefficient of generating functions, Partitions, Exponential Generating Functions, A Summation Method.

Unit 3- Recurrence Relations: Recurrence Relation Models, Divide and conquer Relations, Solution of Linear Recurrence Relations, Solution of Inhomogeneous Recurrence Relations, Solutions with Generating Functions.

Unit 4- Inclusion-Exclusion: Counting with venn diagrams, Inclusion-Exclusion Formula, Restricted Positions and Rook polynomials.

Text Book: Alan Tucker : Applied Combinations Fourth Edition (John Wiley and Sons, Inc). Sections: 5.1 to 5.5, 6.1 to 6.5, 7.1 to 7.5, 8.1 to 8.3, , A4.

Reference Books :

1. V.K. Balkrishnan: Schaum's outline series. Theory and Problems of Combinations (MsGraw Hill).

2. K.D. Joshi: Foundations of Discrete Mathematics (Wiley Eastern Limited).

3. Marshal Hall Jr.: Combinatorial Theory, Second Edition (Wiley Inter science Publications).

Class : M.Sc II (Semester- III)

Paper Code: MAT5302

Paper : II Title of Paper: Field Theory

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- It is a part of pure mathematics which is applicable to fluid dynamics, engineering fields.
- Student will learn field extension, separable extension, Construction of Galois Group and various concepts in Galois theory .

B) Learning Outcome:

Student will understand how to construct field containing all roots of given polynomial equation and applications in Algebraic topology, engineering, Galois theory.

TOPICS/CONTENTS:

Unit 1- Field Extensions :

- Basic Theory of Field Extensions
- Algebraic Extensions
- Classical Straightedge and Compass Constructions
- Splitting Fields and Algebraic Closures
- Separable and Inseparable Extensions
- Cyclotomic Polynomials and Extensions

Unit 2- Galois Theory :

- Basic Definitions
- The Fundamental Theorem of Galois Theory
- Finite Fields
- Galois Groups of Polynomials
- Solvable and Radical Extensions: Insolvability of the Quintic

Text Book :

Dummit and Foote, Abstract Algebra, 2nd Edition, Wiley Eastern Ltd.

Chapters : 13.1 to 13.6, 14.1 to 14.3, 14.6 , 14.7 (statements only)

Reference Books :

1. O. Zariski and P. Sammuel, Commutative Algebra, Vol. 1, Van Nostrand.
2. P. Bhattacharya and S. Jain, Basic Abstract Algebra, Second Edition,

Class : M.Sc II (Semester- III)

Paper Code : MAT5303

Paper : III Title of Paper: Functional Analysis

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- Study of the main properties of bounded operators between Banach and Hilbert spaces
- Study of the basic results associated to different types of convergences in normed spaces
- The spectral theorem and some of its applications.

B) Learning Outcome:

Recognize inner product spaces, Identify duals of some normed spaces, Implementation of Spectral Theorem.

TOPICS/CONTENTS

Unit 1- Banach Spaces:

The definitions and some Examples, Continuous Linear Transformations, The Hahn-Banach theorem, The natural Embedding of N in N^{**} , The Open mapping theorem, The Conjugate of an operator.

Unit 2- Hilbert Spaces:

The definition and some simple properties, Orthogonal complements, Orthonormal sets, The conjugate space H^{*}, The adjoint of an operator, Self adjoint operators, Normal and Unitary operators, Projections.

Unit 3- Finite Dimensional Spectral theory:

Matrices, Determinants and the spectrum of an operator, The Spectral theory.

Text Book: Introduction to Topology and Modern Analysis By G. F. Simmons

Reference Books:

1. B. V. Limaye, Functional Analysis, Wiley Eastern Ltd.
2. Bachman and Narici, Functional Analysis, Narosa Publishing House, India.
3. John B Conway, Introduction to Functional Analysis, Springer.
3. W. Rudin, Functional Analysis, Tata McGraw Hill Edition.

Class : M.Sc II (Semester- III)

Paper Code : MAT5304

Paper : IV Title of Paper: Graph Theory

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To understand and apply the fundamental concepts in graph theory
- To apply graph theory based tools in solving practical problems
- To improve the proof writing skills.

B) Learning Outcome:

The students will be able to apply principles and concepts of graph theory in practical situations.

TOPICS/CONTENTS:

Unit 1- Introduction :

- What is a graph?
- Definitions and examples , Three puzzles

Unit 2- Paths and cycles:

- Connectivity, Eulerian graphs
- Hamiltonian graphs, Some algorithms

Unit 3- Trees:

- Properties of trees, Counting trees
- More applications

Unit 4- Planarity:

- Planar graphs, Euler's formula
- Graphs on other surfaces, Dual graphs
- Infinite graphs

Unit 5- Colouring graphs:

- Colouring vertices, Brooks' theorem
- Colouring maps, Colouring edges
- Chromatic polynomials

Unit 6- Digraphs:

- Definitions, Eulerian digraphs and tournaments
- Markov chains

Unit 7- Matching, marriage and Menger's theorem:

- Hall's 'marriage' theorem
- Menger's theorem, Network flows

Text Book:

Introduction to Graph Theory Fourth edition Robin J. Wilson Chap. 1 to Chap 8

Reference Books: 1) NarsinghDeo, “Graph Theory: With Application to Engineering and Computer Science”, Prentice Hall of India, 2003.

2) Introduction to Graph Theory**,**Douglas Brent West Prentice Hall, 2001.

Class : M.Sc II (Semester- III)

Paper Code: MAT5305

Paper : V Title of Paper : Applied Mathematics I

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To learn spherical trigonometry as a tool in studying Astronomy
- To study various concepts like celestial sphere, coordinate systems phenomenon of refraction

B) Learning Outcome:

Students are able to understand the difference and similarities in plane and Spherical trigonometry. They are also able to understand various celestial phenomenon, like rising and setting of stars, motion of sun, twilight, dip of horizon and effects of refraction on the observation of stars and planets in the sky.

TOPICS/CONTENTS:

Unit 1- Spherical Trigonometry:

- Definitions and Fundamental Formulae.

Unit 2- Right Angle Triangles

Unit 3- Spherical Astronomy:

- Cellestial Sphere
- Coordinate Systems
- Rising and Setting of Stars
- Rate of Change of Zenith and Azimuth
- Motion Of Sun
- Twilight
- Dip of Horizon

Unit 4- Refraction

Text Book:

Spherical Astronomy By M. L. Khanna Published by Jai Prakash Nath and Company Meerut

Reference Books:

Textbook on Spherical Astronomy, Sixth edition, W. M. Smart, Cambridge University Press

Class : M.Sc II (Semester- III)

Paper Code: MAT5306

Paper : VI Title of Paper: Practical-Python

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To learn computer programming language
- To study relation between computer programming and mathematics.
- To develop research attitude in computer software

B) Learning Outcome:

This is most widely used computer programming language and hence student will get opportunities to work in software companies. Also they will understand direct application of mathematics in real life.

Topics/Contents:

Unit 1- Introduction to Python
Unit 2- First Python Program
Unit 3- Datatypes in Python
Unit 4- Operators in Python
Unit 5- Input and Output
Unit 6- Control Statements
Unit 7- Arrays in Python
Unit 8- Strings and Characters
Unit 9- Functions
Unit 10- Lists and tuples
Unit 11- Dictionaries
Unit 12- Introduction to Oops
Unit 13- Classes and Objects
Unit 14- Inheritance and Polymorphism
Unit 15- Abstract Classes and Interfaces
Unit 16- Exceptions
Unit 17- Files in Python
Unit 18- Regular expression in Python
Unit 19- Data structures in Python
Unit 20- Date and time
Unit 21- Threads
Unit 22- Graphical user interface
Unit 23- Networking in python

Text Book:

Core Python Programming- Dr. R. Nageswara Rao, Second Edition, dreamtech press

Class : M.Sc. II (Semester- IV)

Paper Code : MAT5401

Paper : I Title of Paper: Number Theory

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- It is a part of applied mathematics which is applicable to generally every branch of Mathematics.
- It is base for various theorems and construction of proofs.
- Students' will learn various arithmetic functions, Prime Numbers & their properties, Algebraic Numbers, congruence relation.

B) Learning Outcome:

Students are able to understand how to solve Diophantine Equation, how to find solutions of equation $x^2 \equiv a(\mathrm{Nod}\ p)$, Eulers thm , Fermats thm and its application in Field Theory, Algebraic Topology, Complex analysis.

TOPICS/CONTENTS:

Unit 1- Revision :- Divisibility in integers, Division algorithm, G.C.D., L.C.M. Fundamental theorem of arithmetic, The number of primes, Mersene numbers and Fermat's numbers.

Unit 2- Congruences :- Properties of congruence relation, Residue classes their properties Fermat's and Euler's theorems, Wilson's Theorem, Linear congruence of degree one, Chinese remainder theorem.

Unit 3- Arithmetic functions : Euler function, Greatest integer function, Divisor function $\delta(n)$, Mobius function $\mu(n)$, Properties and their inter relation.

Unit 4- Quadratic Reciprocity: - Quadratic residue, Legendre's symbol its properties, Quadratic Reciprocity law, Jacobi symbol its properties, Sums of Two Squares.

Unit 5- Some Diophantine Equations: The equation ax + by = c , simultaneous linear equations.

Unit 6- Algebraic Numbers :- Algebraic Numbers, Algebraic number fields, Algebraic integers, Quadratic fields, Units in Quadratic fields, Primes in Quadratic fields, Unique factorization Primes in quadratic fields having the unique factorization property.

Text Book :- Ivan Niven & H. S. Zuckerman, An introduction to number theory (Wiley Eastern Limited) Sections: 2.1 to 2.4, 3.1 to 3.3, 3.6, 4.1 to 4.4, 5.1, 5.2, and 9.1 to 9.9

Reference Books :-

1. T.M. Apostol, An Introduction to Analytical Number Theory (Springer International Student's Edition)
2. David M Burton, Elementary Number Theory (Universal Book Stall, New Delhi)
3. S. G. Telang, Number Theory (Tata Mc-graw Hill)
4. G. H. Hardy and E. M. Wright, Introduction to Number Theory (Oxford university press)

Class : M.Sc. II (Semester- IV)

Paper Code : MAT5402

Paper : II Title of Paper: Differential Geometry

Credit : 4 No. of lectures: 60

A) Learning Objectives:

To understand the Concept of Level Sets, VectorField, Tangent Space Properties, Surface of Revolution, Gaussian map, Geodesics etc.

B) Learning Outcome:

Students are able to understand the treatment of Level sets, Geodesics, The Weingarten map, smooth curve, line integral.

TOPICS/CONTENTS:

Unit 1-Graphs and Level Sets: Level Set, Graphs of Level Sets.
Unit 2-Vector Field: Dot product, Crossproduct, length of vector, Vector Field Smooth vector Field, Gradient, Parametrized Curve, Divergence, Integral Curve, Complete Vector Field.
Unit 3-The Tangent Space: Tangent to Level Sets, Properties.
Unit 4-Surface: Surface of Revolution.
Unit 5-Vector Field On Surface: Vector Field, Tangent Vector Field, Smooth Vector Field, Normal Vector Field, Connectedness.
Unit 6-The Gauss Map: Gauss Map, Spherical Image of Oriented n-Surfaces.
Unit 7-Geodesics: Speed of α, Geodesics Property.
Unit 8- The Parallel Transport: Vector Field, Covarient Derivatives , Euclidean Parallel , Levi –civita ,Use of parallelism.
Unit 9-The Weingarten Map: Properties of directional derivative, Covarient Derivative of Tangent vector field.
Unit 10-Curvature Of Plane Curve: Significance of sign of k(p) , Global Parametrization.
Unit 11-Arc Length And Line Integral: Arc Length, Fundamental Domain, Differentiable 1-form.

Text Book:

Elementary Topics In Differential Geometry,J.A.Thorpe
(Springer Verlag)

Reference Book:

1) B Oneill: Elementary Differential Geometry (Acedamic New-York).
2) Do CarmoM. :Differential Geometry of Curves and Surfaces.(Englewood Cliffs,N.J.Prentice Hall,1977).

Class : M.Sc II (Semester- IV)

Paper Code: MAT5403

Paper : III Title of Paper: Fourier analysis

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To understand the Concept of orthonormal sets of functions and representations of arbitrary functions by series of functions
- To understand a clear presentation of the classical method of separation of variables used in solving boundary value problems with the aid of those representations.

B) Learning Outcome:

Students are able to understand the treatment of Fourier Series and Their applications to Boundary Value Problems in PDE of Engineering and Physics, Study of Bessel Functions.

TOPICS/CONTENTS:

Unit 1- Fourier Series

Piecewise Continuous Functions, Fourier Cosine Series, Examples, Fourier Sine Series, Examples, Fourier Series, Examples, Adaptations to other Intervals.

Unit 2- Convergence of Fourier Series

One Sided Derivatives, A Property of Fourier Coefficients, Two Lemmas, A Fourier Theorem, Discussion of the theorem and its Corollary, Convergence on other interval, A Lemma, Absolute and Uniform Convergence of Fourier Series, Differentiation of Fourier Series, Integration of Fourier Series.

Unit 3- Fourier Method:

Linear Operators, Principle of Superposition, Temperature, A Vibrating String Problem

Unit 4- Boundary Value Problems:

A slab with faces at prescribed temperatures, Related Problems, A Slab with Internally Generated Heat, Steady Temperatures in a Rectangular Plate, Cylindrical Coordinates.

Unit 5- Orthonormal Sets:

Inner Products and Orthonormal Sets, Examples, Generalized Fourier Series, Examples, Best Approximation in the Mean, Bessel's Inequality and Paeseval's Equation, Applications to Fourier Series.

Unit 6- Sturm-Liouville Problems and Applications:

Regular Strum-Liouvilles Problems, Modifications, Orthogonality of Eigenfunctions, Real valued Eigenfunctions and Nonnegative Eigenvalues, Methods of Solution, Examples of Eigenfunction Expansions, A temperature Problem in Rectangular Coordinates.

Unit 7- Bessel Functions and Applications:

Bessel Functions $J_n(x)$, General Solutions of Bessel's Equation, Recurrence Relations, Bessel's Integral Form, Some Consequences of the Integral Forms, The Zeros of$J_n(x)$, Zeros of Related Functions.

Text Book

Churchill and Brown.: Fourier Seriesand Boundary Value Problems (7^{th} edition) McGraw-Hill

Reference Book:

E. Stein and R. Shakharchi, Fourier Seriesand Boundary Value Problems, New age International

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Class : M.Sc II (Semester- IV)

Paper Code: MAT5404

Paper : IV Title of Paper: Lattice Theory

Credit : 4 No. of lectures: 60

A) Learning Objectives:

- To develop the concept of students in modern and universal algebra related with order, relations etc
- The beauty of Lattice theory is in its extreme simplicity of the basic concept, which is order or partial order
- Generalization of lattice concept by dropping one or more of the lattice identities

B) Learning Outcome:

Student will be able to understand how lattices and Boolean algebra are used as tools and mathematical models in the study of networks.

TOPICS/CONTENTS:

Unit 1- Lattice First Concepts:

- Two definitions of lattices
- Hasse diagrams
- Homomorphism
- Isotone maps
- Ideals and congruence relations
- Congruence lattices
- Product of lattices
- Complete lattice, Ideal lattice, Distributive –Modular inequalities and identifies, complements, pseudo complements
- Boolean lattice of pseudo complements, join and meet-irreducible elements.

Unit 2- Characterization theorems and representation theorems:

- Birkhoff`s distributivity criterion
- Hereditary subsets, rings of sets
- Stone theorems
- Nachbin theorem, statements of Hashimoto's theorem.

Unit 3- Modular and Semimodular lattices:

- Isomorphism theorem
- Upper and lower covering conditions, Kuros-Ore theorem
- Independent sets (Drops results involving projectivity and sublattice generated by sets / elements)
- Jordan-Holder chain condition.

Text Book: General Lattice Theory , G. Gratzer (Birkhauser, IInd Edition 1998) Chap. 1 Section 1,2,3,4,6, Cha. 2 Section-1, Chap.3. Section –1,2.

Reference Books: 1) Lattice Theory: First Concepts and Distributive Lattices, George Gratzer.

2) Lattice Theory **:** Special Topics and applications ,GA Gratzer,FWehrung Springer.

Class : M.Sc II (Semester- IV)

Paper Code: MAT5405

Paper : V Title of Paper: Applied Mathematics II

Credit : 4 No. of lectures: 60

A) Learning Objectives:

Students understand spherical trigonometry which will be used as a tool in studying astronomy. Various concepts like Keplers law, Perihelion, Time , Planetary Motion, Outer Planet Synodic Orital Period will be studied.

B) Learning Outcome:

Students are able to understand Keplers Law, Interior And Superior Planets. Satellite, Sideral Time, Elongation of Planet

TOPICS/CONTENTS:

Unit 1-Keplar's Law of Palnetery Motion: Planets, Inferior and Superior Planets Astroids, Satellites, Keplars 3 law Of planetary motion, Perihelion, Aphelion, Eccentric And True Anamoly, Mean Distance , Heliocentric Distance, Polar Equation Of Ellipse , Kepler's Equation

Unit 2- Time: Sideral Time , Sideral Day, Mean Equinox, Uniform Sideral Day, Sideral Year, Mean Solar Day, Equation Of Time, Causes and length of seasons.

Unit3- Planetary Motion and Phenomenon: Heliocentric longitude and latitude, Conjunction, Heliocentric, geocentric, superior and Inferior Conjunction, Orbital Period, Relation Between Synodic and Orbital Period, Direct Retrograde Motion, GeocentricMotion, Elongation of Planet, Phases of Moon.

Text Book: Spherical Astronomy ByM.L.Khanna- Published by Jai Prakash Nath and Company Meerut(U.P)

Reference Book: Spherical Astronomy By karr.